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A retrospective study of image guided adaptive radiation therapy in prostate cancer

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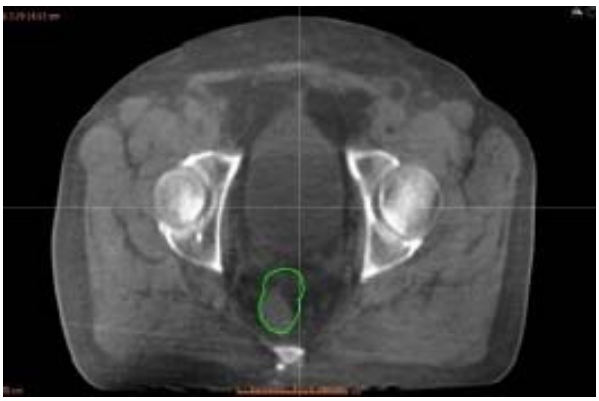
Purpose/Objective: Image Guided Adaptive Radiation Therapy (IGART) uses the Deformable Image Registration (DIR) between Computed Tomography (CT) and Cone-Beam CT (CBCT) images to calculate the delivered dose to the patient during treatment. Using this method we carried out a retrospective study of prostate cancer patients in order to study the weekly variations of delivered dose and evaluate the full treatment projecting on CT the delivered dose previously calculated on CBCT images.

Materials and Methods: Five patients with prostate cancer were selected for a retrospective IGART study. VMAT treatments were planned on CT simulation images with RayStation 4.0 Treatment Planning System (TPS). For every patient, three of the five weekly CBCT studies they had were retrieved. For each CBCT, a Rigid Registration (RR) was made, setting CT and CBCT as primary and secondary images, respectively. Subsequently, a DIR by Hybrid Deformable Registration algorithm was run in order to map the CT's reference structures (ROIs) -external body contour, femoral heads, rectum, prostate and seminal vesicles (SV)- onto CBCT. A radiation oncologist reviewed the mapped structures and modified the non-matching structures by editing them. When some structures were modified was necessary to run a new DIR using these structures as control ROIs. Finally, VMAT plan was calculated on each CBCT and the resulting doses were projected to CT, achieving the total dose delivered on CT. The corresponding dose for the two non-retrieved weekly CBCT studies was estimated using the Raystation IGART module.

Results: One patient was rejected because the field of view (FOV) cut the patient´s surface. The accuracy of DIR for moving structures such as rectum was lower than for fixed structures. Therefore, it was necessary to review the rectum contour and run again a new DIR using this structure as a control ROI. With respect to the external body contour, the weight loss suffered by the patient due to the diet during treatment introduced overdoses which were not computed in the initial dosimetry. One patient showed overdoses in rectum (5.6% and 4.7% for D25 and D20, respectively), whereas another patient showed a 4% overdose in D20. In both cases, the limits prescribed by radiation oncologist were exceeded. On the other hand, the variation of dose in fixed structures such as femoral heads was insignificant. Finally, one patient showed a 7.3% overdose in V98 for SV and 3.7% in V100 for the prostate. In general, a slight tendency to overdose was observed in patients who showed greater weight loss.



Patient	D25	D20	D15
*P1**	*5.6%*	*4.7%*	*2.6%*
*P2**	*0,04*	*3.6%*	*1.6%*
P3	*-2.1%*	*-1.8%*	*-0.4%*
P4	*0.6%*	*0.3%*	*-0.4%*

Conclusions: Shape and volume of some organs, i.e. rectum, fluctuate during the treatment, resulting in a failure to meet the initial prescription doses. The implementation of a weekly IGART protocol study could detect such changes and allows an offline correction through the adaptive treatment.

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Are the dosimetric verification results of spot scanned IMPT fields dependent on field specific parameters?

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Purpose/Objective: A detail analysis of 2437 IMPT fields that were clinically used for patient treatment between 2007 and 2013 at PSI Gantry 1 was performed [1]. The aim of this study was to find out a possible correlation between the results of dosimetric verifications and specific field characteristics.

Materials and Methods: Dosimetric verifications were performed for every IMPT field prior to patient treatment. For every field a steering file was generated containing all the treatment unit information necessary for treatment delivery: beam energy, beam angle, dose, size of air gap, nuclear interaction (NI) correction factor, number of range shifter plates, number of spots with their position and weight. This information was extracted and compared to the results of dosimetric verification of each field which was a measurement of two orthogonal profiles using an orthogonal ionization chamber array in a movable water column.

Results: The data analysis has shown that the difference between measured and calculated dose depends critically on the number of spots and maximal range. Figure 1 displays the dose degradation as a function of the mean range and mean number of spots. An increase of the dose degradation was observed with smaller number of spots (i.e. smaller tumour) and smaller ranges (i.e. superficial tumours). Noteworthy, more than 94% of all verified fields were within defined clinical tolerances. Figure 1 does not reflect the frequency of each measured dose value. The results of the verification do not depend however on the prescribed dose, NI correction or